Bangladesh Med Res Counc Bull 2010; 36: 93-96

# Evaluation of myocardial protection in off-pump vs on-pump coronary bypass surgery by troponin I estimation

Md. Badruzzaman, Aslam Hossain, Asit Baran Adhikary, SA Quader, Sarwar Kamal, Sanjoy Kumar Saha

*Department of Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD), Dhaka, E-mail: badruzzaman2008@gmail.com*

**Abstract**

Background: This prospective non-randomized clinical study was done to compare Off-pump and On-pump myocardial revascularization by Troponin I release in patients undergoing first elective coronary artery bypass graft used to evaluate myocardial injury. Methods: One hundred an twenty patients were non-randomly assigned to a Off-pump or On-pump myocardial revascularization group. Cardiac Troponin I (CTnI) were measured in serial venous blood samples drawn preoperatively in both groups. In On-pump group after aortic unclamping at 12 and 24 hours and in Off-pump group after the last distal anastomosis at 12 and 24 hours. Results: The total amount of CTnI release were significantly higher in On-pump group than in Off-pump group. In On-pump group it was 2.1±1.9 (mean±SD) ng/ml vs in Off-pump group it was 1.0±1.7 (mean±SD) ng/ml at 12 hours and in On-pump group it was 1.6±1.6 (mean±SD) ng/ml vs in Off-pump group it was .9±1.6 (mean±SD) ng/ml at 24 hours ($P<0.0001$ for the pattern). Conclusion: The lower release of CTnI in the Off-pump myocardial revascularization group indicates that the arrested heart coronary revascularization group causes more damage to the heart due to cardiopulmonary bypass than Off-pump myocardial revascularization group.

## Introduction

Atherosclerotic coronary artery disease (CAD) is the most common cause of death in western world. The incidence of ischemic heart disease (IHD) is increasing in developing countries like Bangladesh.

Surgical revascularization by coronary artery bypass grafting (CABG) using Cardiopulmonary bypass (CPB) is widely used, safe and effective procedure with a low mortality rate (1). Off-pump coronary artery bypass (OPCAB) involves bypass grafting on a beating heart without the employment of CPB[2].

Myocardial protection is a damage limitation exercise aimed at minimizing the damage to the heart as a result of the procedure, it is now considered as vital, not only to minimize the damage but also to enhance myocardial reserve and function[3]. An optical surgical result depends on protecting the heart from damage during operation. This necessitates the use of some form of myocardial protection[4]. The need to provide myocardial protection in OPCAB is limited because in the absence of on going ischemia. Only the region subtended by the artery being bypassed should be in jeopardy. In this situation intracoronary shunt is used. Inspite of advanced technique, CPB related mortality due to aortic canulation, cross-clamping of aorta, contact activation of blood to pump and cardioplegic arrest of the heart is still high. It activates numerous cascades, including the Kalikrein, coagulation and complement system. The primary concern is systemic inflammatory response (SIRS) due to release of cytokines[5]. It has been suggested that CTnI specificity to detect myocardial injury may be greater than that of Cardiac troponin T (CTnT)[6]. The aim of this prospective randomized study was to evaluate the myocardial protection in Off-pump CABG group by the estimation of CTnI release and also to compare between Off-pump and On-pump CABG group and their short-term in-hospital outcome.

## Materials and Methods

*Patients selection*

After approval by our institutional review board, informed consent was obtained from all eligible patients. One hundred and twenty patients (104 men and 16 women, mean age of Off-pump and On-pump CABG patients were 52.6±3.8 (mean±SD) years and 53.9±4.6 (mean±SD) years respectively) were enrolled in a prospective non-

randomized trial comparing beating and arrested heart coronary revascularization. All selected patients were eligible for both Off-pump and On-pump revascularization. Not included in this study were patients with aortic incompetence, ejection fraction below 0.30, concomitant heart valve disease or unstable angina, patients undergoing re-operation, elderly patients, evolving myocardial infarction, stroke, emergency CABG and patients with atrial fibrillation (AF).

This study was done in National Institute of Cardiovascular Disease, Dhaka, Bangladesh over two years period. Supervision of data and registration was made by us. Surgical team was told to which group a patient will be randomized just before the incision.

*Operative technique*

In the operating room patient were placed in supine position on the operation table. All the non-invasive monitoring lines like ECG, blood pressure and pulse oxymetry were connected. Two peripheral venous lines were established and one intra-arterial (commonly radial) cannula was established under local anesthesia and connected to a polygraph monitor for continuous blood pressure monitoring. Under general anesthesia central venous pressure (CVP) catheter was introduced and was connected to a polygraph monitor for continuous CVP display. Urinary catheter and rectal temperature probe were introduced. The skin was prepared over the chest, abdomen, groin and complete circumference of both legs including the feet.

A median sternotomy was done and at the same time great saphenous vein was harvested. Internal mammary artery (IMA) was prepared as a pedicle graft.

*In Off-pump CABG group*

In this group the primary target vessels were left anterior descending artery (LAD), diagonal branches (D), right coronary artery (RCA) and Obtuse marginal (OM) branches. After harvesting the arterial and venous conduits the patients received heparin (100 u/kg) before starting distal anastomosis. Proximal and distal grafting was done in conventional procedure.

*In On-pump CABG group*

After harvesting the arterial and venous conduits the patients received heparin (300u/kg). Then CPB was established using aortic canulation and two staged venous canulation in the rt. atrium. Flow during CPB was maintained at about 2.5 l/m/m2. Myocardial protection was achieved by using intermittent antegrade hyperkalaemic cold blood cardioplegia. Proximal and distal grafting were done in conventional procedure.

*Intensive care unit and immediate postoperative management*

After operation all patients were brought to ICU where all the patients were on beat to beat basis cardiac function monitoring.

*Follow up of the patients*

All patients were followed up during the early postoperative period and up to 3 month. During the period they were evaluated clinically as well as by echocardiographically. The improvement of LV function was seen on 3rd. month Postoperatively after discharging from the hospital by echocardiogram.

*Measurement of Cardiac Troponin I (CTnI)*

Serial venous blood samples were drawn preoperatively in both groups as well as aortic unclamping at 12 and 24 hours in the On-pump CABG group and after the last distal anastomosis in Off-pump CABG group at the same time schedule. The CTnI concentration was determined by an immunometric technique.

*Statistical analysis*

Data were collected by interview schedule and check list and analyzed by SPSS and tested by student '*t*' test, Chi-squared test and paired '*t*' test

The total number of patients were 120. The patients were divided in to equal two groups

Off-pump CABG group (n=60)

On-pump CABG group (n=60)

Statistical analysis was performed with a SPSS software. Categorical data were compared with the Chi-squared test and quantitative variables with the two group '*t*' test. Values are expressed as mean±SD. A values of *p* less than or equal to 0.05 was considered statistically significant.

## Results

*Preoperative Data*

There is no significant difference between the age and sex distribution between the two groups. The number of patients suffering from Diabetes Mellitus (DM), AF and LBBB/ RBBB did not differ markedly between the groups. Distribution of NYHA class, risk factors and number of vessel involvement were almost identical in both groups (*Table-1*).

*Operative data*

Total operation time *(Table II)* in Off-pump is significantly less than On-pump CABG. Number of graft was not significantly different. At least one mammary artery graft was given in all cases. The mean difference of total operation time was

significantly higher in On-pump CABG group than Off-pump CABG group.

Period of mechanical ventilation, ICU stay and total hospital stay are significantly lower in Off-pump CABG than On-pump respectively. Distribution of NYHA functional class in both groups was no difference in both groups. But the improvement in Off-pump group is more significant than On-pump group.

The mean difference of LVEF from preoperative to postoperative period was more significant in Off-pump group than On-pump group. In Off-pump group it was 9.4±4.5 (mean±SD)% preoperatively and 5.0±4.1(mean±SD)% postoperatively. The improvement of wall motion abnormality is also more significant in Off-pump than On-pump group.

The preoperative value of CTnI (Table III) was almost similar in patients of both groups. But in the post operative value between two groups is highly significant (*P*=<.001 for the pattern). It was higher in On-pump group than Off-pump group.

*Evaluation of ECG*

It was found that 4 patients in On-pump group and 1 patient in Off-pump group showed evidence of perioperative myocardial infarction (PMI). PMI was characterized by new Q wave of greater than 0.04 ms, and/or a reduction of R waves greater than 25 % in at least two leads.

*Hospital mortality*

It was 1(3.33%) in Off-pump due to peroperative VF, and 2(6.67%) in On-pump, One due to failure to wean from CPB and the other due to low output syndrome.

**Table I:** Preoperative patient Profile by group

| Variables | Off-pump CABG *(n=60)* | On-pump CABG *(n=60)* | *P* Value |
|---|---|---|---|
| Mean age (Yrs.) | 52.60±03.80 (mean±SD) | 53.9±04.60 (mean±SD | NS |
| Sex ratio (M/F) | 05:01 | 09:01 | NS |
| Risk factors distribution | | | |
| Smoker | 36 | 30 | NS |
| Diabetes Mellitus | 20 | 24 | NS |
| Hypertension | 36 | 24 | NS |
| Dislipidaemia | 18 | 10 | |
| Preop. EF% | 51.30±03.60 | 58.10±06.40 | NS |
| Preop. NYHA | | | |
| I | 04(06.70%) | 04(06.70) | NS |
| II | 40(66.70%) | 44(73.30%) | NS |
| III | 16(26.70%) | 12(20.00%) | NS |
| Vessels involved | | | |
| DVD | 24 | 22 | NS |
| TVD | 36 | 38 | NS |

**Table II**: Operative and postoperative data by group

| Variables | Off-pump CABG *(n=60)* | On-pump CABG*(n=60)* | *p* Value |
|---|---|---|---|
| Total operation Time (min) | 174.40±16.40 | 226.00±20.40 | <.001 |
| Totalgrafting/Aortic occlusion time | 107.30±09.70 | 49.70±06.70 | <.001 |
| Number of graft | 02.80± 00.60 | 3.20±00.70 | 1 |
| Mechanical ventilation time (hrs) | 07.00±00.80 | 15.10±02.10 | <.001 |
| ICU stay (hrs) | 27.80±02.30 | 33.90±03.50 | .002 |
| NYHA Class | | | |
| I | 36 | 34 | |
| II | 18 | 20 | |
| III | 04 | 02 | |
| LVEF% | 58.10±06.40 | 63.10±06.40 | <.001 |

**Table III**: Shows the time course of CTnI

| Blood level of CTnI | Off-pump CABG (ng/ml) (mean±SD) | On-pump CABG(ng/ml) (mean±SD) | *P*-value |
|---|---|---|---|
| Preoperative sample value of cTnI | 0.10±.03 | 0.11±.02 | *NS* |
| 12 hrs. after last distal anastomosis in Off-pump and aortic unclamping in On-pump | 1.0±1.7 | 2.1±1.9 | <.0001 |
| 24 hrs after(last distal anastomosis in Off-pump and aortic unclamping in On-pump | 0.9±1.6 | 1.6±1.6 | <.0001 |

## Discussion

Off-pump CABG has gained increasing popularity due to potential to avoid CPB, aortic canulation and cross-clamping and their damaging effect. On-pump CABG causes global ischemia, reperfusion and myocardial injury due to CPB. The aim of this prospective randomized study was to determine CTnI release in Off-pump and On-pump CABG. Cardiac troponin I release was significantly higher in every patient drawn in On-pump. This shows more widespread myocardial injury occurs in On-pump group, whereas the lower release of CTnI in Off-pump group indicates limited myocardial injury. This study is similar to studies of Fraser D and Rubens(7), French et al. (8). Alwan et al. (9) and Gerola et al. (10). In conclusion our study shows that conventional CABG with cardioplegic arrest causes more damage to the heart than does Off-pump as indicated by the lower release of CTnI and this is effected by low total operation time, low ICU stay, low total hospital stay, more improvement LVEF, NYHA functional class and ventricular wall motion abnormality in Off-pump CABG group.

## Acknowledgement

We express our humble gratitude to the almighty that we had completed the work successfully. We also wish to thank Md. Tauhidul Islam, BSc (Hons). MSc (Statistics), Statistical Officer, Bangladesh Buraeu of Statistics for his active cooperation.

### References

1. Pentilla HJ, Lepojarvi KJ, Kiviluoma KB, Kaukorania PK, Hassinen IE, Peukhurinen KJ. Surgery with and without cardiopulmonary bypass. Ann Thorac Surg 2001; 71: 565-71.
2. Park KW, Mahmood F, Chandok D. Perioperative and intraoperative care of the cardiac surgical patients, eds. Sellke WF, Nido DJP, Swanson, SJ, in Sabiston & Spencer Surgery of the Chest. 7th ed. USA: Elsevier Saunders; 2005. 1021-32.
3. Karthik S, Grayson AD, Oo AY, Fabri BM. A survey of current myocardial protection practices during coronary artery bypass grafting. Ann R Coll Surg Engl 2004; 86: 413-5.
4. Bojar RM. Intraoperative considerations in cardiac surgery, in Manual of perioperative care in adult cardiac surgery, 3rd ed. Massachusetts: Blackwell Science; 2005. 207-14.
5. Bojar RM. Intraoperative considerations in cardiac surgery, in Manual of perioperative care in adult cardiac surgery, 3rd ed. Massachusetts: Blackwell Science; 2005. 95-105.
6. Vermes E, Mesguich M, Howel R, Soustelle C, Besnerais LP, Hillion LM, et al. Cardiac Troponin I after open heart surgery: a marker of myocardial protection? Ann Thorac Surg 2000, 70: 2087-90.
7. Fraser D, Rubens. Cardiopulmonary bypass: technique and pathophysiology. In: Sellke WF, Nido DJP, Swanson SJ. eds. Sabiston & Spencer Surgery of the Chest. Vol. 2. 7th ed. USA: Saunders; 2005. 1061-80.
8. French KJ, White DH. Clinical implications of the new definition of myocardial infarction. Heart 2004; 90: 99-106.
9. Alwan K, Falcoz EP, Alwan J, Mouawad W, Oujaimi G, Chocron S, et al. Beating versus arrested heart coronary revascularization, evaluation by cardiac troponin I release. Ann Thorac Surg 2004; 77: 2051-5.
10. Gerola LR, Buffolo E, Jasbic W, Botelho B, Bosco J, Luis A. Off-pump versus On-pump myocardial revascularization in low risk patient with one or two vessel disease, perioperative result in a multicenter randomized trial. Ann Thorac Surg 2004; 77: 569-73.